Heliophysics Summer School 2015

Planetary dynamos and their seasons

Part 2

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Terrestrial planets
- Earth
- Mercury
- Mars

Gas giants
- Jupiter
- Saturn

Ice giants
- Uranus
- Neptune

Satellites
- Ganymede
- Moon
- Europa
- Titan

Exoplanets

Stanley and Glatzmaier “Dynamo models for planets other than Earth”
Part 2: Planetary dynamo simulations

Geodynamo and its dipole reversals (magnetic seasons)

Jovian dynamos and the Juno and Cassini missions
solid inner core
fluid outer core
solid mantle
Radial Component of the Magnetic Field

At surface  
Geomagnetic field (1980) up to degree 12

At core-mantle boundary  
G-R simulation plotted up to degree 12

G-R simulation up to degree 95
Inner core super-rotation
with gravitational coupling
between inner core and mantle
Dipole moment

Pole latitude
Jovian dynamos and the *Juno* and *Cassini* missions
Surface observations of Jupiter

banded atmospheric clouds

banded zonal winds
Latitudinally banded zonal winds

thin shell model
Sanchez-Lavega et al., 2003

Saturn

“Saturn” simulation

Zonal wind velocity (m/s)

Sanchez-Lavega et al., 2003
Zonal winds (differential rotation)

1.0 R

eq plane

depth shell model

zonal ave

80 m/s
Fields displayed in spherical surfaces
at $r = 1.07 \, R_J$ (Juno's perijove)

**perturbed gravity field**

**magnetic field**

**RADIAL components**

- 18 mgal
- 5 g

**COLATITUDINAL components**

- 14 mgal
- 4 g

**LONGITUDINAL components**

- 4 mgal
- 0.2 g
Juno mission to Jupiter
Juno mission to Jupiter
(and Cassini Grand Finale mission to Saturn)

If no banded axisymmetric structures were observed in Juno’s magnetic and gravity data, all strong zonal winds on Jupiter’s surface are likely shallow atmospheric features.

If only broad-banded axisymmetric structures were observed in Juno’s magnetic and gravity data (as in these simulations), Jupiter’s broad low-latitude jets likely extend through the deep interior, but the narrow high-latitude jets are likely shallow atmospheric features.

If banded axisymmetric structures were observed at all latitudes in Juno’s magnetic and gravity data, the zonal winds on Jupiter likely all extend well below the surface, possibly down to a double-diffusive stable stratification in which internal gravity waves exist.